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Non–destructive detection and characterization of debonded interfaces between road layers with a Step Frequency Radar

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Unbounded interface in road layers often leads to more visible damages such as potholes or alligator cracking. It is particularly critical when such defects appear between a wearing surface (top layer of the pavement) and an asphalt base course. The detection and characterization of such debonded interface is a major challenge for road maintenance.

This work presents the Step Frequency Radar as a non destructive tool for the detection and characterization of debonding. First, some basic theoretical aspects of the study remind the ability of electromagnetic methods based on wave propagation to describe debonding. The vertical and spatial resolutions are studied in function of used frequencies and defect dimensions. We also show how the detection threshold highly depends on the debonding type: major differences exist whether a defect is filled with water or air. Second, an experimental study was carried out on the pavement fatigue carrousel of IFSTTAR. The 15 m long studied test track presents three Hot Mix Asphalt (HMA) layers as base and wearing courses. Various objects such as wood, Teflon, kraft paper and sand were buried at different depth in order to simulate debonding or sliding interfaces. The SFR measurements were performed with an ultra wide band antenna centred at 7.5 GHz. The antenna displacement (0.5 cm step, 1 m length profile) above the surface is controlled with a motorized bench. Most of the buried defects were detected at the interfaces between the first (HMA1), second (HMA2) and third (HMA3) layers, except the kraft paper that is indeed too thin (few mm) to be detected. A sand layer was detected at 11 cm depth between HMA2/HMA3 and its thickness estimated at 0.7 cm. he calculated dielectric constant of defects hardly allowed their characterization in term of nature, except for the Teflon (1*20*20 cm) which calculated permittivity is 2.3 at 6 cm depth.

The use of SFR system allows the detection of thin debonding between HMA layers. It requires the use of high frequencies because the wavelength in HMA must match at least half the defect thickness. The characterization of the material filling the debonding remains problematic: the accuracy on the dielectric constant evaluation decreases as the defect depth increases. Moreover, the defect thickness, even if debonding is detected, is often too thin to assess precisely the dielectric constant, which is based on amplitude signal measurement of the reflected waves at the various interfaces.

Future works will present the comparison between different NDT, as infrared thermography and acoustic methods, carried out on the same test track.